

**REMARKS:**

Applicant thanks the Examiner for the Office Action of August 26.

Applicant has amended claims 1 and 18 and pages 10-11 of the specification.

Bracketed and underlined versions of all amendments are attached hereto as Attachment A.

**The Objection to the Drawings Is Overcome by New Proposed Fig. 19**

In the Office Action, the Examiner objected to the drawings as failing to be labeled "Prior Art". This objection is respectfully traversed. To the best of Applicant's knowledge, none of the existing figures depicts prior art processes. However, in order to more clearly distinguish the differences between the invention and at least one prior art system, Applicant has contemporaneously submitted a Proposed New Drawing. Proposed new Figure 19 (labeled as "Prior Art") depicts one prior art system for generating polysulfides in white liquor. Applicant points out that the depiction of this one prior art system is distinguished from the present invention in that proposed new Figure 18 adds oxygen to the causticizers.

**The Claims Particularly Point Out and Distinctly Claim the Invention**

In the Office Action, the Examiner rejected claims 1, 4, 18, 20 and 21 under 35 U.S.C. 112, second paragraph, as indefinite.

With respect to claim 1, the Examiner objected to phrase, "the catalyst", as lacking antecedent support. Applicant has amended claim 1 to correct this. As such, it is believed that the rejection has been overcome.

With respect to both claims 1 and 18, the Examiner objected to the recitation, "g/l", because he was uncertain as to what the liters pertained. Applicant has amended each of these claims to clearly indicate that the concentration is in terms of the grams of the transition metal oxide catalyst liters per liter of the liquor. As such, it is also believed that this rejection has been overcome.

With respect to claims 4 and 20-21, the Examiner objected to the term, "self-circulated reactor". The Examiner takes the position that such a term is defined as "circulation of a fluid without requiring external circulation-inducing means, (...) such as by the force of gravity". The Examiner also takes the position that Applicant's use of this term is contrary to the Examiner's definition. Applicant respectfully traverses this rejection.

While Applicant recognizes that a term in a claim may sometimes not be given a meaning repugnant to the usual meaning of the term, Applicant asserts that the term as defined by the specification is not repugnant in the manner suggested by the Examiner. As shown in FIGS. 5-11, and described at ln. 20, pg. 10 through ln. 16, pg. 21 of the specification, oxygen that is recirculated through the reactor. Whether oxygen is originally introduced at the top or the bottom of the reactor, it is pulled through an orifice near the top of the shaft down through the turbine, thereby creating oxygen bubbles. As the oxygen bubbles

upwardly, some of it reacts with the liquor. The portion of oxygen not reacted with the liquor continues to bubble up into the headspace. It is considered recirculated, because the oxygen circulates from the headspace to the liquor and back to the headspace. This description is consistent with the Examiner's definition, since it is the low density of the oxygen that causes it to rise through the liquor, not the stirring of the shaft.

### **The Claimed Invention Is Patentable Over the Cited References**

In the Office Action, the Examiner rejected claims 1-3, 5-19 and 22 under 35 U.S.C. 102 (b) as anticipated by WIPO patent publication number WO 97/42372 (the '372 reference), or in the alternative, under 35 U.S.C. 103 (a) as obvious over the '372 reference in view of U.S. Patent 5,607,233 (the '233 patent). This rejection is respectfully traversed.

The claimed process is directed to reacting sodium sulfide with oxygen in the presence of a transition metal oxide catalyst in a liquor (with a concentration of 0.05 to 6.5 grams catalyst per liter of liquor), where the consumption rate of O<sub>2</sub> is at least 1.5x10<sup>-4</sup> moles/l/sec, such that a selectivity of polysulfides greater than 65% is achieved. Another aspect of the claimed process is directed to reacting sodium sulfide with oxygen in the presence of a transition metal oxide in a liquor (with a concentration of 0.05 to 6.5 grams of transition metal oxide per liter of liquor), where the partial pressure and consumption rate of O<sub>2</sub> are controlled, such that a selectivity of polysulfides greater than 85% is achieved. The inventors have unexpectedly found that selectivity of polysulfides may be

increased to such relatively high numbers without overly increasing the concentration of catalyst used. Because a transition metal oxide such as MnO<sub>2</sub> is a contaminant in the overall Kraft cooking process, the present invention allows minimization of such a catalyst. Also, because the selectivity achieved is so relatively high, formation of deadload in the cooking cycle is minimized.

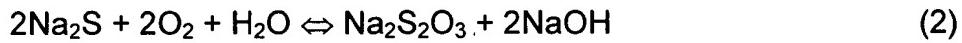
On the other hand, the '372 reference discloses reaction of sodium sulfide with oxygen in the presence of a catalyst having a concentration of 1-20% by weight of the liquor (Ins. 5-7, pg. 8). While the '372 reference discloses an ambiguous 10-15% increase in polysulfide yield over the state of the art in 1996, it is silent as to polysulfide selectivity.

Applicant respectfully asserts that the '372 reference fails to disclose, teach or suggest a transition metal oxide concentration of 0.05 to 6.5 grams per liter of liquor. As noted above, the '372 reference discloses a preferred metal catalyst concentration of 1-20% by weight of the liquor. Applicant attaches hereto, as Attachment B, a copy of a publication showing a typical white liquor specific gravity of 1.13 at 95°C (203F°). Assuming useage of MnO<sub>2</sub> as the metal catalyst and this specific gravity, the catalyst weight percentage of the '372 reference corresponds to a concentration of 11.3-226 grams of MnO<sub>2</sub> per liter of liquor, a concentration far exceeding that of the claimed invention. This is not surprising since the process of the '372 reference utilizes a centrifuge device to separate out catalyst from the oxidized liquor.

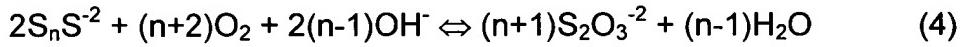
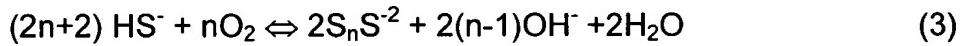
The '372 reference also fails to disclose, teach or suggest a polysulfide selectivity of greater than 65%. Selectivity can be more important than yield in

the Kraft cooking process. Because a relatively high yield coupled with a relatively lower selectivity can create an undesirable amount of deadload, especially thiosulfate, the two numbers are not interchangeable or amenable to conversion. An explanation of the significant distinction between these two numbers may be found below.

Polysulfides may be formed by oxidizing white liquor with an oxygen-containing gas. Two competing reactions are present during this oxidation:



Reaction (1) leads to the formation of polysulfides, while reaction (2) produces thiosulfate, which is corrosive, and represents a dead load during the cooking cycle. The promote reaction (1), the use of a catalyst, such as a transition metal oxide, is needed. The complete set of reactions can be written in terms of the hydrosulfide ion, which is present in water:



The natural pathway is equation (5), which leads to the formation of sodium thiosulfate which is undesirable because it is corrosive and creates a process deadload. Other reactions (6) and (7) also result in sulfite and sulfate, each of which is also deadload. Even if polysulfides are produced, they are unstable and can be readily converted to thiosulfate through equation (4). Thus, it is very

important to control the polysulfide generation process so that polysulfide is maximized and deadload is minimized.

The above goal is measured by the selectivity of the process, which may be defined as: ((polysulfides formed) / (converted sulfide)) X 100. Yield, on the other hand, may be defined as: ((polysulfides formed) / (initial sulfide)) X 100. Selectivity is in many ways more important than yield. For example, assume that the initial sulfide concentration is 20g/l (as S) and 8g/l polysulfide (as S) is produced. If yield is the only parameter examined, this would appear to be an efficient process, i.e., a polysulfide yield of 40%. However, if the residual Na<sub>2</sub>S is 7g/l, it would mean that 5g/l Na<sub>2</sub>S was oxidized to deadload thereby giving a polysulfide selectivity of 61.5%. If the residual Na<sub>2</sub>S concentration is 10g/l, only 2g/l was oxidized to deadload, thereby resulting in a significantly higher polysulfide selectivity, i.e., 80%, for the same yield.

The '372 reference fails to appreciate or even address the above oxidation side reactions or the above distinction between yield and selectivity. Indeed, at lines 1-3 and 14-16 of page 9, the '372 reference discloses that an overabundance of oxygen is not detrimental, but may even be preferred. If oxygen is added in such a relatively indiscriminate manner, it is Applicant's belief that the above oxidation side-reactions could negatively affect selectivity.

Finally, the Examiner takes the position that the yield disclosed by the '372 reference and the selectivity of the claimed invention are both "conversion efficiencies" that would suggest no unobvious distinction to one skilled in the art. However, the Examiner fails to show how the two measurements are equivalent

or obvious. In order to provide a legally sufficient inherency argument, the Examiner must point to some technical rationale showing why one measurement would suggest the other. Applicant respectfully asserts that the Examiner has not provided such a rationale. In the absence of a compelling rationale equating the two measurements (if such a rationale even exists), Applicant believes that it has provided an affirmative, persuasive argument disproving inherency. This is evidenced by at least the difference in catalyst concentration utilized. Moreover, the Examiner has not provided any evidence that one skilled in the art would consider the two measurements equivalent or at least obvious variants.

Applicant also respectfully asserts that the teachings of the '233 patent fail to correct the deficiencies of the '372 reference. The Examiner has not shown how the '233 patent teaches the advantages of the claimed catalyst concentration and selectivity.

For the foregoing reasons, Applicant believes that this rejection has been overcome.

The Examiner also rejected claims 1-22 under 35 U.S.C. 103 (a) as obvious over the '372 reference in view of the '233 patent and U.S. Patent 5,082,526 (the '526 patent). This rejection is respectfully traversed.

As shown above, neither the '372 reference nor the '233 patent, alone or in combination, disclose, teach or suggest all of the claimed limitations, such as the claimed catalyst concentration and selectivity. The teachings of the '526

patent fail to remedy these deficiencies. Thus, Applicant believes that this rejection has been overcome.

Applicant further respectfully asserts that the claimed invention is patentable over the remaining art of record, either alone or in combination. In the Office Action, although the Examiner identifies other art of record, he fails to point out how any of it, alone or in combination, discloses, teaches or suggests the claimed invention. Applicant respectfully asserts that none of the remaining art of record does disclose, teach or suggest all of the claim limitations, especially the claimed catalyst concentration and selectivity.

In conclusion, for the reasons explained above, Applicant believes that claims 1-22 are patentable, thereby placing the application in condition for allowance. Applicant respectfully requests allowance of the same.

Should the Examiner believe that a telephone call would expedite prosecution of the application, he is invited to call the undersigned attorney at the number listed below. A petition for a two-month extension of time is being contemporaneously submitted with this submission with the required fee, along with an Information Disclosure Statement and a Proposed Drawing Correction. Otherwise, it is believed that no fee is due at this time. If that belief is incorrect, please debit deposit account number 01-1375.

Respectfully submitted,

*Chris Cronin*

Christopher J. Cronin  
Registration No. 46,513

Air Liquide  
2700 Post Oak Blvd.  
Suite 1800  
Houston, TX 77056  
(708) 579-7925  
(708) 579-7801 (fax)

Date: January 27, 2003

*[Signature]*

## **ATTACHMENT A: UNDERLINED AND BRACKETED AMENDMENTS**

### **IN THE SPECIFICATION:**

Please replace the paragraph starting at line 14 of page 10 and ending at line 8 of page 11 with the following paragraph:

In a most preferred embodiment of the present invention, the self-recirculated reactor used for the reaction is a hollow shaft reactor. Such reactors are depicted in Figures 5-10 of the drawing, and are more particularly described in copending U.S. Application No. [ ] 09/784,150 (Attorney Docket No. 016499-895/Serie 5540), filed concurrently herewith. White liquor is introduced in the reactor through the inlet 120. Oxygen gas of at least 80 % concentration is introduced in the reactor through the gas inlet 100. The shaft 107, which is hollow, recirculates the oxygen and water vapor from the orifice 115 to the turbine 112. Th recirculation allows 100 % consumption of the gas and therefore no gas outlet is required. The orange liquor exits through the liquor outlet 117. In yet another embodiment, shown in FIGURE 6, the oxygen-containing gas is introduced from a perforated pipe 125 located under the turubine. The unreacted oxygen is then recirculated through the shaft 107. In another embodiment, FIGURE 7, a gas with inerts greater than that found in commercially pure oxygen is introduced through the inlet 125. A large fraction of the unreacted oxygen-inert mixture is recirculated through the hollow shaft 107. A smaller fraction of the unreacted mixture is removed via a purge 127 which controls the oxygen partial

pressure. In another embodiment, FIGURE 8, another turbine 140 is added to maintain the catalyst in suspension. In yet another embodiment, FIGURE 9 shows that the oxygen-containing gas is recirculated through a double envelope 142 around the shaft 107 of the reactor. In another embodiment, FIGURE 10, the oxygen-containing gas is introduced 150 directly in the double envelope 142 of the shaft 107.

**IN THE CLAIMS:**

1. (Once Amended) A process for preparing polysulfides for use in a Kraft cooking liquor, comprising:

a) providing a liquor having therein sodium sulfide, oxygen and a transition metal catalyst; and

b) reacting the sodium sulfide with the oxygen in the presence of [a] the transition metal oxide catalyst, with the concentration of the catalyst in the liquor ranging from 0.05 to 6.5 g/l, where the consumption rate of O<sub>2</sub> is at least 1.5x10<sup>-4</sup> moles/l/sec, such that a selectivity of polysulfides greater than 65% is achieved.

18. (Once Amended) A process for preparing polysulfides for use in a Kraft cooking liquor, comprising:

a) providing a liquor having therein Na<sub>2</sub>S, oxygen and a transition metal oxide; and

reacting the Na<sub>2</sub>S with the oxygen in the presence of [a] the transition metal oxide, with a concentration of the metal oxide in the liquor ranging from 0.05 to 6.5 g/l, and where the consumption rate of O<sub>2</sub> is sufficient and the partial pressure of oxygen is controlled to achieve a selectivity of polysulfides greater than at least 85%.

**CERTIFICATE OF MAILING UNDER 37 CFR 1.8(a)**

I hereby certify that this correspondence is being deposited with the United States Postal Service with sufficient postage as first class mail in an envelope addressed to:

Assistant Commission for Patents  
Washington, DC 20231

On this 27<sup>th</sup> day of January, 2003.



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Christopher J. Cronin  
Registration Number 46,513